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POSITION CLASSIFICATION STANDARD FOR CHEMICAL ENGINEERING SERIES, GS-0893

Workforce Compensation and Performance Service

Theodore Roosevelt Building 1900 E Street, NW Washington, DC 20415-8330 Classification Programs Division

Chemical Engineering Series

GS-0893

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SERIES DEFINITION

This series includes positions that involve professional work in chemical engineering, including research, development, design, operation, evaluation, and improvement of processes, plants, equipment, methods, or products. The work involves changes in the chemical composition or physical state of materials and requires primarily application of knowledge of the principles and practices of chemical engineering, chemistry, and other scientific and engineering disciplines.

This standard supersedes the standard for the Chemical Engineering Series, GS-0893, published in June 1959.

OCCUPATIONAL INFORMATION

Professional positions in chemical engineering, like those in other branches of engineering, require application of basic principles, concepts, and techniques of higher mathematics, various physical and engineering sciences, and, in some cases, biological or social sciences. Chemical engineering positions are characterized specifically by the intensive application of basic principles of chemistry and the fundamentals of chemical engineering. Typical of these are material balances, energy balances, kinetics of reacting systems, transport of mass and energy, and economic balances.

Work in chemical engineering is concerned with the conditions which produce and control changes of state or composition of materials. These changes are commonly defined as unit operations and unit processes.

Unit operation refers to a physical operation by which a desired step in a process is controlled or conducted. Most chemical processes can be broken down into these units. They include handling of materials, fluid flow, heat transfer, size reduction, filtration, distillation, and a number of other physical operations that bring about movement or physical changes, whether or not any chemical change takes place.

Unit process refers to a change in chemical composition, which may be one of a series of reactions leading to the final product or series of related products. Unit processes include hydrolysis, nitration, sulfonation, chlorination, oxidation, fermentation, reduction, hydrogenation, polymerization, and catalytic cracking.

NOTE: The term "unit process" should be carefully differentiated from the broader and more general term "process."

The process(es) for achieving the desired end product may involve any one or a combination of physical operations or changes in chemical composition of materials.

Chemical engineers in the Federal service engage in diverse activities. They are in research, development, production, pilot plant operation, test, regulatory work and other functions.

The positions covered by the grade-level criteria in this standard are engaged in such nonsupervisory professional engineering work as the following:

1. Planning special and commercial equipment for process systems in pilot plants and laboratories, including preparation of specifications and cost estimates for equipment and structures;

2. determining type and engineering specifications of instrumentation and apparatus for measuring physical properties of in-process chemicals;

3. operating pilot plants;

4. preparing equipment installation plans;

5. developing and determining compliance with regulations, standards, and guidelines for control of pollutants or for handling and storage of hazardous materials;

6. providing advisory and consultative services to State and local agencies and others concerning the nature of water pollutants and air pollutant emissions and systems and methods for controlling them, in the chemical and related industries;

7. conducting economic feasibility studies of newly developed processes and products, including the projection of data obtained from bench or pilot plant scale, in order to determine attributes and facilities of full-scale industrial plants.

Some positions may require specialization in only one area whereas others may require involvement in any combination of two or more areas of work. The extent to which candidates possess related specialized experience should be considered in selective placement for such positions and other personnel actions.

EXCLUSIONS

The following kinds of positions are excluded from the Chemical Engineering Series, GS-0893, because of the nature of the paramount qualifications required and the primary emphasis of the work:

1. Positions involving application of a practical knowledge of chemical engineering methods and techniques as distinguished from full professional knowledge of chemical engineering. Such positions are classified in the Engineering Technician Series, GS-0802; Engineering Drafting Series, GS-0818; or other appropriate series. For further discussion of professional-technician relationships, refer to the introductory material for the Engineering and Architecture Group, GS-0800.

2. Positions that require primarily application of specialized knowledge of the principles and practices of another engineering field, e.g., to design mechanical equipment for use

in unit processes and operations, or to design instrumentation for chemical processing and control systems. Such positions are classified in the Mechanical Engineering Series, GS-0830; Electrical Engineering Series, GS-0850; or Electronics Engineering Series, GS-0855, as appropriate.

3. Positions that involve chemical engineering work in combination with work characteristic of several additional engineering fields or series where no one is predominant. Such positions are classified in the General Engineering Series, GS-0801.

4. Positions concerned with the extraction of metals from their ores, when the work requires primarily full professional knowledge of metallurgical principles and techniques rather than broad knowledge of chemical engineering. Such positions are classified in the Metallurgy Series, GS-1321.

   Work that involves primarily the following is specifically excluded from the Chemical Engineering Series: Physical metallurgy, i.e., determination of the mechanical and physical properties of metals, metal behaviors, metallographic examination of metals, development of metals and alloys for specific uses; pyrometallurgy, i.e., smelting and refining of ores, reduction of iron and steel and related alloys; mineral dressing, the nonchemical or physical aspects of extractive metallurgy, i.e., mineral testing, beneficiation of submarginal or complex ores by application of crushing, grinding, gravity separation, centrifuging, flotation, magnetic separation, electrostatic recovery, and others. These areas of work are historically and educationally associated with the metallurgist.

5. Positions concerned primarily with uncovering basic scientific information about conditions necessary for conducting a chemical reaction in the laboratory, and developing primary data on yields. Such positions typically do not require knowledge of chemical engineering principles and practices; therefore those positions are classified in the Chemistry Series, GS-1320. When the emphasis of the positions is on containing and controlling the chemical reactions involved in a process in a safe, efficient, and reproducible manner, on an industrial or commercial scale, including consideration of costs, equipment, manpower, and industrial process specifications, the positions are classified in the Chemical Engineering Series, GS-0893.

6. Positions that require primarily specialized knowledge of materials and materials sciences for selecting materials for use where the emphasis of the work is on the interrelationships of composition, structure, and properties. Such positions are classified in the Materials Engineering Series, GS-0806. However, if the emphasis of the work is on unit physical operations and unit chemical processes involved in a chemical manufacturing or other plant, the positions are classified in the Chemical Engineering Series, GS-0893.

7. Engineering positions that require primarily application of specialized knowledge of chemistry and biological science to work pertaining to water pollution control, solid waste disposal, and air pollution control, if the primary emphasis of the work is on the

extent to which control and treatment systems affect the quality of air, land, and water resources. Such positions are classified in the Sanitary Engineering Series, GS-0819. However, if the primary emphasis of the positions is on the unit chemical processes, unit physical operations, and associated equipment used by industrial plants, sewage plants, etc., the positions are classified in the Chemical Engineering Series, GS-0893.

8. Positions concerned primarily with extraction of petroleum or natural gas from the ground. Such positions are classified in the Petroleum Engineering Series, GS-0881. However, when the emphasis of the positions is on the unit chemical processes, unit physical operations, and equipment used in refining petroleum, separating helium from natural gas, or for processing natural gas, the positions are classified in the Chemical Engineering Series, GS-0893.

TITLES

Chemical Engineer is the authorized title for positions classified to this series.

Supervisory Chemical Engineer is the authorized title for positions that require supervisory qualifications.

COVERAGE OF GRADE-LEVEL CRITERIA

This standard includes grade-level criteria for nonsupervisory chemical engineer positions in grades GS-5 through GS-13 that involve functions other than those covered by grade-evaluation guides. Nonsupervisory positions in the covered functions at grades GS-14 and above are highly individualized. It is not practicable to provide grade-level criteria for such positions. Positions at GS-14 and above should be evaluated by extension of criteria in this standard in accordance with sound position-classification judgment. Also, the General Grade-Evaluation Guide for Nonsupervisory Professional Engineering Positions, GS-0800, may be used for evaluation of positions above GS-13.

OTHER STANDARDS TO USE IN DETERMINING GRADE LEVELS OF POSITIONS

Chemical engineer positions engaged primarily in the types of work listed below should be evaluated by use of the appropriate grade-evaluation guides rather than the criteria in this standard.

Research. -- Positions engaged primarily in basic and applied research should be evaluated by reference to the Research Grade-Evaluation Guide.

Research Grants. -- Positions engaged in reviewing, evaluating, and recommending approval of research grants and contracts should be evaluated by reference to the Research Grants Grade-Evaluation Guide.

Development. -- Positions concerned with in-house or contract development of equipment and systems should be evaluated by reference to the Equipment Development Grade-Evaluation guide. Positions concerned with experimental development of processes should also be evaluated by Part III, Experimental Development, of that Guide.

Production. -- Positions concerned primarily with various aspects of the fabrication and manufacture of new equipment, materials, machines, and devices or the production-type repair, overhaul, and assembly of such products should be evaluated by reference to the Grade-Evaluation Guide for Engineer Positions Concerned with Production, GS-0800.

Test and Evaluation. -- Positions concerned primarily with testing and evaluating processes, items, and products should be evaluated by reference to the Test and Evaluation Engineering Grade-Evaluation Guide, GS-800.

Education. -- Positions requiring professional knowledge of engineering, but which are engaged primarily in education programs should be evaluated by reference to the Grade-Evaluation Guide for Instructor and Specialist Positions Involving Education and Training Work.

Supervision. -- Supervisory positions should be evaluated by reference to the General Schedule Supervisory Guide.

Valuation. -- Chemical engineering positions engaged in determining rates of depreciation or in estimating costs or the fair exchange worth of specific chemical plants should be evaluated by reference to the Valuation Engineering Grade-Evaluation Guide, GS-0800.

In addition to the grade-evaluation guides for certain functions, the General Grade-Evaluation Guide for Nonsupervisory Professional Engineering Positions, GS-0800, may be used as a supplement to this standard. It will be especially useful for positions with functions or responsibilities not adequately covered by the criteria in this standard.

EVALUATION FACTORS

Two factors determine the degree of difficulty and complexity and level of responsibility for chemical engineering positions covered by the grade-level criteria in this standard. The factors are: *Nature of assignments and Level of responsibility*.

Qualification requirements are not described separately; instead the Nature of assignments and Level of responsibility factors reflect them.

Nature of assignments

This factor deals with:

-- Nature, difficulty, and variety of work;

-- Originality required;

-- Knowledge and judgment required.

At the lower levels, assignments are characterized by narrow scope and limited factors for consideration. At the higher levels, assignments are complex and therefore require broad knowledge of chemical engineering and perhaps some knowledge of a related physical or biological science, or branch of engineering. The items, processes, operations, and materials involved at the higher levels are typically complex and relate closely to other programs, processes, items, etc. Thus, the engineers must comprehend the intricate relationship between the particular processes, operations, specialized areas, etc., and related ones in order to consider the implications and impact that changes or certain courses of action have on those programs.

At lower levels, adequate data, drawings, and related precedent are typically available. This is because the work at the lower levels typically involves widely known and proven unit processes and physical operations, plant equipment, and materials of the specialized area. The higher-level work often involves equipment, processes, materials, etc., that are not standard, or are under development, or that are highly advanced. Typically, there is inadequate data and actual operating experience to reference.

Some degree of judgment may be necessary for evaluating and selecting from among various standard methods at lower levels. By comparison, higher-level positions require greater judgment and considerable knowledge of chemical engineering principles and actual practice in order to modify established approaches and to arrive at sound engineering compromises. Also, some higher-level positions require originality for devising new approaches to meet novel situations.

Chemical engineers at all levels are expected to follow advancing technology in their field. At the higher levels particularly, the engineers apply in-depth knowledge of advanced technology to their typical assignments. At these levels the engineers innovate and improve upon traditional ways of doing things and they deal with the unusual and new situations.

Level of responsibility

This factor deals with:

-- Supervision received;
-- availability and pertinency of guidelines;
-- nature, scope and impact of commitments, recommendations, determinations, etc.; and
-- nature and purpose of personal contacts.

At the lower levels, supervision is relatively close. The supervisors or more experienced engineers are readily available to give guidance or advice. At the higher levels, chemical engineers work independently. Assignments at the higher levels require that the engineers (1) draw upon their broad knowledge and experience in the specialized area, (2) be very knowledgeable of the latest concepts and developments in their specialized areas and related ones in order to ingeniously devise new approaches or establish new guidelines.

At the lower levels, equipment catalogs, guidelines on chemical engineering, and other pertinent topics are adequate. Assignments can typically be completed by direct application or slight adaptation of precedent approaches or prescribed format.

Advice at the lower levels is limited in scope; there is precedent for the advice and it receives technical review. At the higher levels, chemical engineers make recommendations and give advice on highly important matters. Their advice and recommendations carry considerable weight and may result in policy changes, because of the reliance on their technical competence.

At lower levels, personal contacts are diverse, but tend to be with engineers in the same activity. At higher levels, engineers represent the employing activity at scientific and technical meetings, and in meetings with engineers from private industry. They must be able to defend their positions on matters when faced with competent opposition or critics.

GRADE-LEVEL CRITERIA

CHEMICAL ENGINEER, GS-0893-05

Nature of assignments

GS-5 chemical engineers are trainees. Their assignments require application of fundamental knowledge of the principles and practices of chemical engineering, such as would be acquired through completion of a bachelor's degree in engineering.

Carefully selected assignments orient the trainees in the practical application of their knowledge to the various types of work performed in their particular offices or specialized areas. GS-5 chemical engineers commonly work with more experienced engineers to observe and learn how to perform various aspects of the work.

Level of responsibility

GS-5 chemical engineers work under the close supervision of their supervisors or more experienced engineers. The trainees receive detailed instructions at the time of assignment. Supervisors provide trainees with the necessary background information and guidance materials for each assignment, or show the trainees where to find it. The supervisors are readily available to provide guidance on any problems encountered. They check the work while it is underway. The supervisors review details of the completed work, including proper application of standard formulas, accuracy of computations, and accuracy of conclusions.

Reference material or precedents are fully applicable to specific assignments. GS-5 chemical engineers refer unusual situations which are not covered by their instructions to their supervisors.

The personal contacts of GS-5 chemical engineers are for purposes of information gathering or other very routine purposes, primarily within the employing activity. Contacts with supervisory personnel and workers throughout the organization may be for the purpose of becoming familiar with local systems and procedures; for example, with chemical plant personnel to obtain information on plant layout or standard plant equipment.

CHEMICAL ENGINEER, GS-0893-07

Nature of assignments

Assignments of GS-7 chemical engineers require them to apply knowledge of the basic work processes and a number of standard procedures and practices in the specialized area, e.g., process evaluation or pilot plant operation. By comparison, assignments of GS-5 chemical engineers require no previous knowledge of the work and procedures of the specialized area.

GS-7 chemical engineers carry out assignments that are typically narrow in scope with only a few factors to consider. The assignments may be complete projects in themselves, or narrow aspects of considerably broader projects that are coordinated by more experienced engineers.

Supervisors plan the assignments of GS-7 chemical engineers with the goal of developing the engineers for higher-level work. Commonly, GS-7 chemical engineers review previously completed and approved projects to update data, calculations, and drawings, in order that the projects reflect changes in data, technology, or policy.

GS-7 chemical engineers apply limited judgment in (1) occasionally making minor adaptations of precedent solutions and approaches to specific assigned problems, and (2) planning the details for accomplishing assignments. By comparison, GS-5 engineers lack the experience on which to base these judgments, that reflect experience.

Level of responsibility

GS-7 chemical engineers receive instructions on the goals of the assignments and the appropriate precedents or guidelines to follow. Supervisors are available to answer questions or provide guidance on unanticipated aspects of the work, which are outside the GS-7 engineers' experience. Supervisors thoroughly review and approve the findings and recommendations before they become bases for action. Supervisors spotcheck the work while it is in progress when aspects of the work involve process techniques, procedures, or lines of approach that are new to the GS-7 engineers. By comparison, supervisors check the work of GS-5 chemical engineers while it is in progress and closely supervise them.

GS-7 chemical engineers apply directly relevant guidelines and background reference material in their work. However, the supervisor may supplement the guidelines and reference material with instructions and guidance in their application.

In their contacts, GS-7 chemical engineers characteristically give limited, routine information to or secure it from personnel within their own organizations. However, they may accompany more experienced engineers or their supervisors in outside contacts, as part of their development.

CHEMICAL ENGINEER, GS-0893-09

Nature of assignments

GS-9 chemical engineers carry out a broad range of recurring and conventional assignments that characterize their specialized areas. Assignments of GS-9 chemical engineers are composed of several phases, each requiring independent analysis and solution. GS-9 engineers coordinate and integrate these for overall solutions. By comparison, assignments of GS-7 chemical engineers are limited and narrow, requiring analysis and solution, but not coordination and integration with other phases. The assignments of GS-9 chemical engineers may be complete in themselves or segments of larger and more comprehensive projects. When the assignments of GS-9 chemical engineers are segments of an even greater overall assignment, the engineers must consider the effect that their recommendations will have on the overall project. Thus, this level requires sharp analytical skills.

Chemical Engineers GS-9 independently apply knowledge of: (1) Chemical engineering principles, (2) various standard methods for carrying out and controlling typical physical operations and chemical reactions in the specialized area, (3) standard types of equipment, instrumentation and facilities used in the specialized area, (4) agency policy and guidelines, and (5) previously-used approaches. The engineers use sound judgment in determining the most suitable precedents for particular assignments, and in adapting these precedents, procedures, or techniques to the requirements of the assignment. GS-9 chemical engineers in regulatory work must be able to make reasonable interpretation and application of agency guidelines. They require this ability to examine plant designs, pollution control systems, and processing techniques of standard design, in order to determine extent of compliance with the guidelines.

The following assignments are illustrative:

1. Analyzes a standard process, to determine the impact of modified techniques on the cost of economically producing the material, and whether suitable plant equipment is available to meet the new requirements. The material is a well-known low-energy or non-toxic one. The unit chemical processes are standard ones but the proposed process incorporates some modified physical operations for controlling or conducting size reduction and separation of materials. Uses the process developer's flow sheets for the basic reference.

-- Compiles a technical report, taking care to provide updated information on such aspects as: Anticipated equipment costs, operating costs, technical evaluation of overall process, and return on the investment.

-- Uses available data to verify the computed process conditions and physical properties.

-- Applies the agency's standard equations and factors to preparation of cost data.

-- Designs a hypothetical commercial or industrial-scale process for production of the material. This design package includes further refined process flow sheets, verified data on process performance specifications, size of major items of equipment, utility requirements, construction materials for each piece of equipment, and general equipment layout.

-- Specifies changes to the computer program that simulates the process, applying knowledge of mathematical simulation techniques.

-- Uses standard commercially available equipment illustrated and described in process industry equipment catalogs and chemical engineering handbooks in most operations of the process, with little or no modification.

2. Prepares detailed engineering specifications and cost estimates for the purchase or construction of equipment and process control instruments. The assignments require understanding of the processing operations in which the equipment will be used. Also, the engineer must know the characteristics of the chemical materials to be processed in the equipment to determine compatibility between the chemicals and the materials of construction. In instrumentation design assignments, the engineer must understand the various processing operations involved, in terms of process flow, pressure requirements, physical characteristics at various temperatures, chemical properties, etc. The engineer oversees the installation of the item, and evaluates adequacy of installation and whether item meets performance requirements of the specifications. The engineer finds precedent design approaches or similar items in other installations or industry catalogs and handbooks that he adapts or modifies. The modifications may amount to change in size and capacity of equipment, construction materials, registration range, readability of dials, etc.

3. Operates and evaluates a small pilot plant for removal of a particular mineral from emissions of a coal-fired powerplant. There are specific instructions as to the operation; the pilot plant uses several standard unit operations. The assignment calls for variance of operating conditions, e.g., material flow rates, compositions of the waste gases by using different types of coals, etc. The work requires knowledge of extractive chemistry.

Level of responsibility

Supervisors or more experienced engineers make assignments to GS-9 chemical engineers, after having screened them for unusual problems or matters of potentially great impact. The supervisors or team leaders thoroughly review the completed work for technical accuracy and soundness of approach, attainment of goals, and compliance with policy.

GS-9 chemical engineers can normally perform their assigned work by applying their knowledge of engineering practices, interpreting the established policy, and selecting and adapting the suitable precedents. By comparison, supervisors tell GS-7 engineers which precedent to follow. The nature of the specific references and guidelines varies with the nature of the individual position or specialized area; however, standard formulas, statistical methods, engineering drawings, process specifications, and test data are usually adequate and available. If the GS-9 chemical engineers encounter difficulty in relating guidelines or adapting precedents to their projects, supervisors are typically readily available to provide guidance.

The GS-9 engineers' basic findings and recommendations are sound. However, supervisors may find it necessary to request clarification or additional development of some points.

Though GS-9 chemical engineers characteristically give interpretations and opinions on a variety of matters to personnel within their own organizations, authority to commit the organization to a course of action is normally reserved for their supervisors or engineers of higher grade. Those limited instances in which GS-9 chemical engineers have commitment authority in dealing with outside organizations are confined to cases where the supervisor has clearly outlined in detail the conditions which must prevail.

Contacts of GS-9 engineers are typically within the same installation, but they also have independent contacts with engineers and other technical personnel outside the immediate organization and installation. By comparison, contacts of GS-7 chemical engineers outside the immediate organization and installation, are in the company of more experienced engineers or supervisors. GS-9 chemical engineers who plan equipment for use in pilot plants deal principally with workers in the same organization, such as chemists, research or process development engineers, to obtain information on functional requirements and discuss technical problems regarding the operation of the equipment. In pilot plant operating positions, contacts are with plant equipment operators and development engineers, to exchange information or to explain change in the plant operation or data collection procedures.

CHEMICAL ENGINEER, GS-0893-11

Nature of assignments

GS-11 chemical engineers perform a wide range of professional engineering duties related to a specialized area, e.g., the separation of helium gas or pollution control techniques for powerplants.

Assignments at this level are characterized by:

-- broad scope;
-- a variety of factors that require separate analysis and coordination;
-- requirement for substantial amount of modification of precedent approaches;
-- difficulty in relating particular aspects of the assignments to guidelines or precedents.

Because of the breadth of typical GS-11 assignments, GS-11 engineers must be knowledgeable in related scientific and engineering areas, e. g., toxicology, metallurgy, thermodynamics. However, they do not necessarily have to possess the level of knowledge of specialists in those fields, but must comprehend the interrelationship between their primary specialization and the related areas. The GS-11 chemical engineers determine the kinds of information they need from the other specialists and integrate the data and designs they provide, to arrive at the desired results.

The assignments of GS-11 chemical engineers require broad experience in the specialized area, to interpret, adapt, and supplement available guidelines and precedents. Since ideally suited precedents do not always exist at this level, the GS-11 chemical engineers must draw upon their personal experience in related situations to modify or adapt precedents. The engineers apply sound judgment in evaluating sources and quality of information to arrive at sound compromises and decisions on methodology to follow. By comparison, methodology of GS-9 engineers conforms to accepted practice.

The GS-11 chemical engineers apply seasoned judgment in determining the optimum methods for carrying out unit chemical processes and operations and in designing special process equipment. They must understand the processes and operations involved, and know the various types of equipment that can be used for each process and operation. Experience typically enables them to discount certain methods and equipment quickly without having to go through time-consuming analysis or costly trial-and-error.

The following assignments are illustrative:

1. Designs special equipment to be used in carrying out standard unit physical operations in a pilot plant. Due to the special nature of the materials to be processed, many exacting operating and functional requirements, or other comparable complications, the engineer must depart from existing designs to determine construction materials with the appropriate chemical resistance, or to devise a means of maintaining closer tolerances in

the equipment operation. Refers to process flow sheet which gives information on flows, temperatures, pressures, physical characteristics, etc. Applies knowledge of means for inducing and controlling chemical reactions and for controlling the physical state of materials, of properties of materials, of the specialized area, and of mechanical design principles. Makes many compromises between the ideal characteristics of the equipment and such practical considerations as cost, reliability, repairability, standardization and personnel required to operate in order to determine equipment's specifications.

2. Directs operation of a pilot plant that involves numerous standard but complicated operations and articles of equipment. The goal of the pilot plant project is to develop an economically feasible method for producing a new substance with very specific qualities and characteristics, or to improve the operating techniques for a full-scale production plant. Relies upon the developer's flow sheets, operating instructions, and explanations of desired objectives for each stage of the process.

   -- Changes methods of reaction to improve quality or amount of yield.
   -- Varies reaction rates or end product by changing the operating conditions, (e.g., increased temperature for the unit process).
   -- Varies arrangement of piping or equipment to increase efficiency or yield.

3. Evaluates the economic feasibility of an improved method of municipal sewage treatment and extraction of usable materials, to very precise standards. The process involves modified techniques for the unit processes and operations. The assignment requires broad knowledge of the various methods for conducting and controlling the physical operations and chemical reactions normally used in sewage treatment.

   -- Selects the major equipment for process reactions and physical operations.
   -- Specifies design requirements for a few non-standard, hypothetical items of major equipment for use in the plant layout, capital cost estimates, and determining utility costs.
   -- Analyzes each step of the process to uncover technical problems that might occur in the detailed design, construction, and operation of a full-scale plant.
   -- Makes suggestions for modifications to the process in order to reduce costs.
   -- Uses standard techniques of statistics and mathematical modeling to verify the practicality of the hypothetical plant design.

4. Makes thorough engineering-economic evaluations of a variety of the more difficult pollution control plans for new plant installations, with respect to their ability to meet specific standards. The proposed methods and equipment basically adhere to previously-used ones but involve modifications in equipment design and process technique for the particular installation. Based on such considerations as plant capacity and computed emission rate, judges overall adequacy of the proposed plan. Requires current knowledge of the standard pollutants and standard methods of control for a variety of industries and process operations.

Level of responsibility

GS-11 chemical engineers normally plan the details of their own assignments and select the procedures, methodology, etc. The engineers submit periodic progress reports to the supervisors for review. They consult supervisors, who make suggestions on how to handle the more difficult and unusual technical problems. This is especially true in instances where (1) a course of action or approach requires departure from precedents or illustrates inadequacies in precedents, or (2) problems relating to deadlines, priorities, funds, and availability of equipment arise. Supervisors review the completed work of GS-11 chemical engineers for nature of results obtained, soundness of engineering conclusions and recommendations, and to insure that all factors have been considered. Making engineering deviations in planning and accomplishing the broader engineering assignments is typical of this level. Literature on new or improved processes, regulatory guidelines, chemical and engineering theories, and concepts and equipment is available for use by GS-11 chemical engineers. These materials are typically not wholly adequate, not complete, or not specific enough for use without further analysis, improvement, or change by the engineers.

Contacts of GS-11 chemical engineers are characteristically with a wide variety of persons ranging from plant construction workers and pilot plant workers to engineers and scientists in research or development, and engineers at chemical plants, in Government and industry. Contacts of GS-11 chemical engineers typically are with persons outside the immediate activity or installation. By comparison, contacts of GS-9 chemical engineers, while they may be diverse, are still typically within the same installation. Contacts of GS-11 chemical engineers tend more often to be those in which they have decision-making or commitment authority on matters that they judge to be within guidelines or that conform to precedent. By comparison, GS-9 engineers make commitments on such matters only when the supervisor has anticipated them and given precise instructions on the conditions that must prevail. GS-11 chemical engineers make recommendations which result in revisions to projects that often result in major savings without altering function or life expectancy of facilities. GS-11 chemical engineers make recommendations that the supervisors generally approve with little change.

CHEMICAL ENGINEER, GS-0893-12

Nature of assignments

The novel considerations involved in assignments of GS-12 chemical engineers require the engineers to apply particularly extensive knowledge of a broader or unusually complicated specialized area of chemical engineering. By comparison, GS-11 assignments are typically complicated and difficult, but involve more traditional concepts. The assignments of GS-12 engineers typically require use or understanding of advanced plant equipment, products, materials, and techniques for carrying out unit processes and physical operations. The requirement for considerable competence in related disciplines, e.g., extractive metallurgy or electrical engineering, is very pronounced at this level.

Technical data and background information that GS-12 chemical engineers receive at the time of assignments usually have major discrepancies, are inadequate, or are scanty. This consideration in combination with the inadequacy or lack of related precedent, the involvement with advanced equipment, processes, etc., requires considerable breadth and variety of experience. This

experience provides them with the high degree of technical judgment, originality, and resourcefulness required to:

-- Develop and execute specific action plans for extensive and knotty projects from the broad objectives outlined by the supervisor;
-- recognize possible new approaches and devise new or improved techniques and methods for obtaining effective results;
-- overcome difficult and unusual problems where guides and precedents are inadequate or even lacking;
-- discern undesirable trends;
-- apply pertinent technological advances to the specialized area;
-- analyze and evaluate designs, process proposals, and ideas submitted by others;
-- recognize critical issues that should be referred to the supervisor or others; and
-- coordinate the specialized area with related aspects of other programs, specialized areas, or engineering fields.

The following assignments are illustrative:

1. Evaluates feasibility, practicality, and economics of a new process that is in the pilot development stage. The process involves several reactions or physical operations for which there is inadequate background information, particularly on such critical areas as material balances, heat balances, pre-treatment of raw materials, yield, and materials of construction. There may also be inadequate literature on a unit process or there may be a problem of what to do about recycle buildup or undesirable by-products.

   -- Devises calculation methods or formulas when the necessary information is not available and justifies them.
   -- Conducts tests in a pilot plant or laboratory to obtain needed data on flow rates, starting materials, operating pressures, etc.
   -- Evaluates hypothetical plants of various proportional dimensions to determine optimum size, based on general data provided for one size.
   -- Prepares cost estimates during development that guide the direction of development by comparing the relative economics of alternative processing steps or equipment.
   -- Prepares design requirements for novel reaction or handling equipment.

   The unusual features of the plant require the engineer to devise his own factors for determining costs, rather than use standard ones. He consults the development engineer for additional background information, or contacts consulting companies who work in the particular field of knowledge.

2. Makes engineering-economic evaluation of proposed emission control methods for a new electric-generating plant. The control method involves novel equipment and techniques for removal of the undesirable gases from flue effluent. Requires up-to-date knowledge of the appropriate industrial and combustion processes, economic analysis, and methods of controlling emissions from the combustion processes (through removal of pollutants from stack effluents, raw material changes, and process changes). Suggests improvements in the process or control method that contribute to increased efficiency or economy of the emission control method.

Level of responsibility

Review of the work of GS-12 chemical engineers is essentially for (1) nature of findings and recommendations and (2) conformance of approaches and conclusions to existing policy. Supervisors indicate the general objectives or operational requirements but not how to meet them, at the time of assignment. GS-12 engineers discuss with supervisors matters which have policy implications, far-reaching impact, or raise critical issues. Since their assignments are not only difficult, but typically broad as well, GS-12 engineers sometimes exercise technical direction over subordinate engineers for the duration of a particular project. As team leaders GS-12 engineers review and coordinate the work of the subordinate engineers.

Because of the characteristic nonapplicability of established criteria and technical precedents and the inadequacy of available data, GS-12 chemical engineers develop essentially new or vastly improved techniques to accomplish their assignments. By comparison, GS-11 engineers utilize new techniques which GS-12 engineers develop. Supervisors normally assume the recommendations and findings of GS-12 chemical engineers to be technically accurate and arrived at through use of sound engineering judgment. By comparison, supervisors review completed assignments of GS-11 engineers for soundness of recommendations and findings.

Recommendations of GS-12 engineers often are the basis for decisive action, such as the cancellation of development work on a new process or item. Supervisors usually permit GS-12 engineers considerable freedom to speak for the organization in giving interpretations and stating the organization's position in various situations that are covered by existing policy. For instance they testify at conferences, public hearings, etc., in connection with regulatory and investigative work. These situations may also involve coordinative meetings with engineers and technical personnel who represent related projects or program areas. Other conferences may be professional society meetings, or technical reviews of development or production programs.

In some situations the GS-12 chemical engineers must quickly make on-the-spot decisions of a decisive nature; such as when a hazard or deficiency in the operation of a pilot plan develops that could result in the loss of life, many hours of effort, or the plant itself if not promptly corrected. GS-12 engineers may meet with research and development personnel to advise them on the means for meeting their requirements for novel equipment and instrumentation to be used in pilot plant or laboratory scale work. By comparison, similar advisory work of GS-11 engineers pertains to equipment and instrumentation for meeting relatively conventional requirements.

GS-12 chemical engineers have many contacts with engineers and scientists who are authorities in other fields for specialized assistance; these contacts are to exchange information and coordinate matters of mutual concern. Other contacts require the GS-12 engineers to exercise tact and discretion in persuading engineers within the employing activity, other agencies, and in industry to: (1) follow a certain course of action, (2) divulge useful information on developmental efforts, (3) undertake certain research programs and joint ventures, (4) resolve differences, and (5) utilize processes or products developed by the activity.

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Nature of assignments

GS-13 chemical engineers typically undertake unique and controversial assignments within a major specialized but complex area. Individual projects involve state-of-the-art technology, such as a complete process that combines several unusual or new process techniques to be used for the first time on a continuous basis or in industrial production. GS-13 chemical engineers may also be technical advisors or program coordinators, for a specialized area of a broad and varied chemical engineering program. By comparison, GS-12 engineers do not usually coordinate programs of broad scope. This specialized area may be built around: a function, such as process evaluation, state-of-the-art materials, a particular process as applied to many materials, unit processes and operations associated with a particular industry, e.g., pulp and paper, or a family of related products, e.g., incendiary and flame-throwing devices.

GS-13 assignments require comprehensive knowledge of the overall chemical engineering field and particular expertise in the specialized area. Additionally, due to the breadth and complexity of GS-13 assignments, the engineers must apply substantial knowledge of the physical and biological sciences and other considerations which might enter into assignments. For instance, in a product improvement assignment on a flame-resistant garment, the engineer would have to consider human factors, fiber impregnation, and the technology of flame-resistant chemicals.

GS-13 chemical engineers must apply originality, since assignments are characterized by unique or controversial problems. The outcome of the assignments has direct impact on extensive and important engineering programs. As technical specialists, GS-13 chemical engineers exercise initiative and judgment in applying and adapting their broad knowledge of chemical engineering theories, practices, and precedents to their assignments. GS-13 chemical engineers apply technical judgment in isolating essential features of problems, in developing new techniques for performing the work, and in devising compromises. They show ingenuity and originality in developing criteria and devising special equipment and techniques for application to particularly novel and complicated processes.

The nature of their assignments demands that GS-13 chemical engineers in particular, as compared to lower-level engineers, keep abreast of the technological advances in chemical engineering and related disciplines. GS-13 chemical engineers are instrumental in assessing and proposing items or processes for further research, development, or improvement.

The following assignments are illustrative:

1. Evaluates feasibility, practicality, and economics of processes that characteristically require use of novel methods and equipment to conduct unit operations and unit processes. Such projects require extensive literature search. Typically, the processes have been conducted only on a laboratory or bench scale and there is little laboratory data that the engineer can use in designing a hypothetical industrial-scale plant and determining costs. The assignments extend over a long period and involve much consultation with research and development engineers, or initiation of further research on unclear or unrefined aspects, e.g., physical properties of materials, handling of materials, corrosion problems, rates of heat transfer. Uses judgment in determining the necessary skills for operating the simulated plant and the associated wage rates, and evaluating validity and reliability of information sources when there are no precedents. Considers the limitations of construction, manufacture, and shipping before proposing characteristics of industrial-scale equipment.

2. Serves as technical advisor on industrial waste and pollution problems involving the air or water environment. The responsibility covers a large and varied industrial category, e. g., heavy chemicals, petroleum, pulp and paper. The work requires unusually broad experience and knowledge of the diversity of manufacturing processes and operations, and pollution problems and control methods associated with the specialized area.

   -- Makes engineering evaluations of novel pollution abatement and control programs from the standpoint of technical and economic feasibility, while alert to possible changes in industrial processes or raw materials that would facilitate reducing pollution or enhance effectiveness of control methods.
   -- Determines need for and formulates guidelines and standards governing permissible emission levels.
   -- Analyzes and interprets legislation for its impact on the specialized area.
   -- Advises engineers in subordinate organizations on the resolution of unprecedented enforcement problems.
   -- Reviews and recommends disposition of suits against violators of discharge permits.
   -- Meets with violators' representatives to negotiate a course of action that is amenable to all parties.

Level of responsibility

GS-13 chemical engineers prepare their own work plans, establish their own guidelines, and new techniques since existing ones are usually inadequate. They work within the framework of prescribed policy, but may propose significant policy changes when they judge such changes to be needed.

Applicable criteria, pertinent approaches, and reliable technical data which GS-13 chemical engineers can use in carrying out their projects, are typically absent.

The recommendations and decisions made by engineers at GS-13 are of major importance to the activity and the agency. Typically, the disposition of large amounts of money and manpower is contingent upon the recommendations of GS-13 chemical engineers. Because of the professional

stature of GS-13 chemical engineers, their judgment on the technical and economic feasibility and probable fruitfulness of controversial major projects are usually conclusive. By comparison, supervisors and managers do not typically so regard the judgments of GS-12 engineers on such matters.

GS-13 chemical engineers have a variety of personal contacts with key engineers and managers at the employing activity, other agencies or commands, and in private industry. They represent the organization at high-level conferences and meetings on matters within the specialized area. On such occasions GS-13 chemical engineers negotiate with representatives of the other organizations or programs in an effort to reach compromises on disputed matters or they testify as expert witnesses in important court cases.